July 13, 2007

The Dow Chemical Company
Midland, Michigan 48674
USA

George W. Bruchmann, Chief
Waste and Hazardous Materials Division
State of Michigan Department of Environmental Quality
Constitution Hall
525 West Allegan Street
Lansing, MI 48909-7741

RE: Saginaw River / Bay Remedial Investigation Scope of Work

Dear George:

Enclosed please find The Dow Chemical Company's Scope of Work (SOW) for conducting a Remedial Investigation of the Saginaw River and Saginaw Bay, as required in Condition XI.B.6 of the Midland-Operations Hazardous Waste Management Facility Operating License (License) issued by the Michigan Department of Environmental Quality (MDEQ) on June 12, 2003.

This SOW is submitted to MDEQ for review and approval in advance of the required August 11, 2007 deadline specified in the License in the interest of moving this process forward as quickly as possible. We hope to begin preparation of a work plan for the first phase of field work immediately with the goal to initiate field work under an approved SOW and work plan in September, before the end of the 2007 field season.

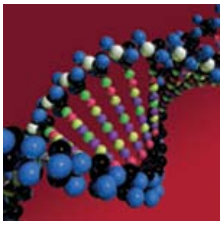
We look forward to working with you and your staff. Please contact me at (989) 636-0787 to discuss next steps in this process.

Sincerely,

Ben Baker

Ben Baker
Sr. Environmental Project Leader
Sustainable Development
633 Building
Midland, MI 48674

Enclosures(s)


REMEDIAL INVESTIGATION SCOPE OF WORK
FOR THE
SAGINAW RIVER AND SAGINAW BAY, MICHIGAN

Prepared for

THE DOW CHEMICAL COMPANY

Prepared by

ENVIRON

13 July 2007

CONTENTS

TABLES

1. INTRODUCTION

This *Saginaw River / Bay Remedial Investigation (RI) - Scope of Work (SOW)* has been prepared by The Dow Chemical Company (Dow) in accordance with the requirements set forth by the Michigan Department of Environmental Quality (MDEQ) under the terms of Dow's Hazardous Waste Operating License (License) for addressing corrective actions beyond the boundary of the Michigan Operations-Midland Plant located in Midland, Michigan. Condition Part XI, Section B.6 of the License requires Dow to submit a SOW to MDEQ for conducting an RI for certain offsite areas. This SOW addresses the work to be performed in Saginaw River / Bay sediments and floodplain. The work proposed herein also is consistent with the January 2005 *Framework for an Agreement between the State of Michigan and The Dow Chemical Company* for addressing concerns regarding the Saginaw River and Saginaw Bay.

1.1 Purpose and Overview

Table 1-1 indicates how this SOW addresses MDEQ requirements and expectations for performing the work described herein as set forth in Dow's License. The work will be conducted to meet applicable requirements of the License, Parts 111 and 201 of Act 451, as well as relevant Resource Conservation and Recovery Act (RCRA) regulations. The Saginaw River / Bay RI Work Plan (Work Plan) will be developed to provide the information necessary to support a risk-based decision process and achieve the goal of a remedial investigation as set forth in R 299.5528, "*The purpose of a remedial investigation is to assess site conditions in order to select an appropriate remedial action, if one is required, that adequately addresses those conditions.*" The Work Plan will also be designed to address the factors described in R 299.5528 (3), "*…as appropriate to the facility…*", and to collect data useful to assessment of natural resource damages.

1.2 Approach

1.2.1 Objectives

Data quality objectives (DQOs) will be proposed in the Work Plan and applied throughout the process that clearly identify the questions that will be answered by data generated from work activities and ensure that the proper type and quality of data are collected. The types of questions to be addressed include, for example, the following:

- Are there relationships between geospatial factors (elevation, geomorphology, river hydrodynamics, land use, etc.,) and the presence or absence in sediments of dioxins and other potential constituents of concern (PCOIs) associated with historical releases from the Dow Midland Plant?

- What PCOIs have the most influence on ecological and/or human health risks and the need for remedial actions; is the occurrence of PCOIs associated with historical releases from the Dow Midland Plant?

- From evaluation of the available historical information and data generated during work, what are appropriate and cost-effective remedial actions to address site-specific risks?

1.2.2 Implementation of the Work

The purpose of this SOW is to provide a general description of the process, steps, and schedule for implementation of work activities in the Saginaw River / Bay. Specific planning and implementation details will be developed and presented in the Work Plan. The Work Plan will be prepared and submitted to MDEQ within 60 days from approval of this SOW. Performance of the work is based on the following sequence of activities:

a. Preparation and submission of a SOW,
b. Compilation of available environmental information relevant to understanding current conditions in the river/bay and identify data gaps,
c. Submittal of Work Plans after approval of the SOW,
d. Implementation of field sampling and survey activities to fill data gaps necessary to make risk management decisions and to evaluate potential risks to human health and the environment, and
e. Preparation of work summary reports.

a. Development of the SOW

Under the terms of Dow's License, a SOW that describes the scope and schedule of work activities that will be conducted in the Saginaw River / Bay must be submitted to MDEQ within 60 days of June 12, 2007, or before August 11, 2007. A Work Plan is due within 60 days of the approval of this SOW.

b. Saginaw River / Bay Current Conditions

In conjunction with preparing the Work Plan, available information describing current environmental conditions in Saginaw River and Saginaw Bay will be compiled and summarized. This information will be reported in a *Current Conditions Report for the Saginaw River / Bay* and used to identify data gaps important to addressing data quality objectives and to guide the development of investigation activities. Based on the existing information and interpretation of current environmental conditions reported in the available studies and technical reports, it is possible that some aspects of the river and bay may be well understood and require little, if any, further investigation and characterization.

The *Current Conditions Report* will provide the basis for further environmental characterization of the river and bay that would target the collection of data to (a) fulfill site characterization needs, and/or (b) support the determination of the need for interim remedial actions (IRAs), pilot corrective action projects (PCAPs), and the design of final corrective actions (CAs).

c. Preparation of Work Plans

Following submission of the SOW to MDEQ, detailed Work Plans will be prepared describing field activities to be initiated beginning in September 2007. To complete the work described in the SOW, investigation activities will be conducted in three phases; each phase will be supported by a Work Plan – one work plan will be prepared for each phase of work. The Work Plan for Phase 1 activities will include more specific information regarding the different proposed work activities such as sample locations, numbers of samples, sample matrices, analyses and methods, sampling frequency and duration, risk assessment activities, survey methods, project schedule, health and safety, data quality objectives, and quality assurance requirements. Similarly, Phase 2 and Phase 3 Work Plans will provide specific information regarding modeling and risk assessment studies and other work activities that are considered necessary to complete the Work described in the SOW. The standard operating procedures, investigation and testing methods, and other supporting project support activities will reflect, to the extent practical, the approaches adopted for the Tittabawassee River RIWP.

d. Implementation of Field Investigation Activities

Field investigation activities will build on existing knowledge and address data gaps identified in a *Current Conditions Report*. Work will focus on the Saginaw River (beginning at the confluence with the Tittabawassee and Shiawassee Rivers and extending to Saginaw Bay) and Saginaw Bay. Saginaw River studies will target hydrodynamic conditions, river bottom and river bank sediments, sediment transport within the river, floodplain areas immediately adjacent to the river, as appropriate, biological and ecological conditions, potential for human exposure to contaminants, and surface water conditions. Saginaw Bay studies will focus on hydrodynamics, sediment transport within the bay, bay sediments and beachfronts proximate to the mouth of the Saginaw River, biological and ecological conditions, potential for human exposure to contaminants, and the drinking water supply delivered to shore from water intake structures located in the bay.

The Work will be conducted in a phased approach over an approximately 21-month period beginning in September 2007. In Phase 1, certain field sampling and survey activities will be initiated in September 2007 and data collection completed by mid-November, when winter conditions are likely to impede the ability to perform field work safely. Field investigation activities conducted in 2007 will support data analysis, a conceptual site model, preliminary hydrodynamic modeling and risk assessment work conducted during the winter 2007/08 (Phase 2 work) and establish a foundation for additional sampling and surveys to characterize conditions in the river and bay in 2008 (Phase 3 work).

Field investigation activities proposed to begin in September 2007 (Phase 1 work) will include the following:

- Topographic, bathymetric, and geophysical surveys,
- Installation of water level and flow meters (hydrologic monitoring),
- River morphological studies,

- Geospatial analysis of available data to determine the need for focused river / bay sediment sampling,
- Sampling of sediments from certain beaches in Saginaw Bay, and
- Sampling of water from drinking water intakes located in Saginaw Bay.

A work plan for Phase 2 activities will be prepared concurrently with the implementation of Phase 1 work. During Phase 2 work, a work plan describing the scope of activities proposed to begin in April 2008 as part of Phase 3 work will be prepared. Field work conducted in 2008 will be based, in part, on river and bay information generated in 2007 and focus on filling the remaining data gaps identified in a *Current Conditions Report* and/or address any new information needs identified during Phases 1 and 2.

e. Preparation of Work Summary Reports

Several deliverables and reports describing the status of work activities, data, and interpretation of findings will be prepared periodically throughout the course of the Work. Deliverables will include quarterly summaries of data, Phase 1, 2, and 3 Work Plans, Phase 1, 2, and 3 summary reports of findings, and the overall final Saginaw River / Bay report.

2. SCOPE OF WORK

The primary purpose of the work summarized in this SOW is to characterize the fate and transport of substances originating from the Dow Midland Plant and transported via the Tittabawassee River through the Saginaw River and into Saginaw Bay, as well as any associated risks to human health and the environment. The Work identifies four major objectives: (1) to supplement the current understanding of chemical and physical characterization data in river and bay sediments and ecological and human health exposure and risk, (2) to evaluate the need for and/or implement interim actions and inform future remedy alternatives analysis and remedy decision-making, (3) to support the development or refinement of the current sediment management strategy for the entire Saginaw River and Saginaw Bay, particularly with regard to the final solution for both the Tittabawassee River and Saginaw River / Bay, and (4) to support other activities that will contribute to the evaluation and identification of appropriate final remedies to mitigate any significant human or ecological risks.

2.1 Definition of Study Area

The study area includes the Saginaw River and Saginaw Bay. In the Saginaw River, the study area begins at the eastern point of Green Point Island, at the confluence of the Tittabawassee River and the Shiawassee River just south of Saginaw, Michigan. From the confluence, the Saginaw River flows north for 22.3 miles through Saginaw County and Bay County, and through the cities of Saginaw, Zilwaukee, Bay City, and Essexville and ends at the confluence with Saginaw Bay. In Saginaw Bay, the study area begins at the confluence with the Saginaw River and extends into areas of the bay where MDEQ has identified areas of potential concern (e.g., water intakes and certain beaches along the bay).

The Saginaw River is divided into the following three reaches. The Upper Saginaw River (USR) extends from the confluence with the Tittabawassee River to (but not including) the Sixth Street Turning Basin, a distance of approximately five river miles. The Lower Saginaw River in Saginaw County (LSR-SC) extends from the Sixth Street Turning Basin to the Saginaw County-Bay County boundary, a distance of approximately six river miles. The Lower Saginaw River in Bay County or LSR-BC extends from the Saginaw County-Bay County boundary to the mouth of the river at Saginaw Bay, a distance of approximately 11 river miles.

Work activities will be confined to (a) sediments and surface water in Saginaw River, (b) levees and banks in the river where evidence of sediment deposition exists, (c) floodplain soils along the river where evidence of flooding and sediment deposition exists, and (d) Saginaw Bay as defined in this SOW. This delineation suggests a tiered approach that does not presume contamination exists in all areas, but rather uses geostatistics, modeling, and the progressive collection of data to identify areas of potential interest. The proposed approach to delineation will focus the Work by limiting the number of areas along the river that require investigation, focusing on those areas that pose the greatest concern. Work activities will not extend beyond the estimated FEMA 100-year floodplain boundary.

2.2 Proposed Investigation Activities

Work activities will be conducted in a phased approach. Phase 1 activities proposed for Fall 2007, Phase 2 activities in Winter 2007/08 and Phase 3 activities in Spring/Summer 2008 will support the preparation of a final report of Saginaw River / Bay findings during the Winter 2008/09. Winter 2007/2008 is anticipated to be a period for data analysis and scope of work refinement bridging field work activities in Phase 1 and Phase 3. During the field work, data will be collected to improve the understanding of sediment physical stability, chemical stability, and human use and ecological/biological community conditions. Work activities proposed for 2007 and 2008 include the following:

Phase 1 (2007) Activities to Supplement/Improve the Understanding of Sediment Physical Stability

1. Topographic, Bathymetric, and Geophysical Surveys
    - Topography of the floodplain.
    - Bathymetry of the river and southwest portions of the bay.
    - Geophysical surveys in the river and at the confluence with the bay, including magnetometery, side scan sonar, and sub-bottom profiling.
2. Hydrologic Study Initiation
    - Installation of water level and flow meters.
3. River Morphological Studies
    - River sinuosity measurements.
    - Identify and characterize sediment deposits, levees, scour areas, plants, and their structures.
    - Analytical interpretations of geophysical and topographic data.
    - Video / GIS survey on the river.
    - River bank classification survey on the river based on slope, degree of undercutting, vegetation and other surface cover, physical nature of the bank material, and related physical factors and geomorphologic characteristics that contribute to bank stability.
4. River / Bay Sediment and Surface Water Sampling
    - Physical characterization of sediments, such as particle size distribution, suspended solids, bulk density, porosity, total organic carbon, redox conditions, or pH.
    - Collection of sediments from certain beaches along Saginaw Bay and testing for dioxins and other PCOIs.
    - Collection of water derived from water intakes located in the bay and testing for dioxins and other PCOIs.
5. Development of Phase 2 Work Plan

Phase 1 (2007) Activities to Supplement/Improve the Understanding of Sediment Chemical Stability

1. Geospatial Analysis Supporting Focused River / Bay Sediment Sampling
    - Review and geostatistical analysis of existing sediment chemistry data.
    - Conduct verification sampling, if warranted, at targeted locations to confirm the results of the geostatistical analysis.

Phase 2 (2007 / 2008) Preliminary Data Analysis & Modeling and Phase 3 Work Plan Development

1. Continue Sediment Physical Stability Analysis
    - Preliminary hydrologic modeling to understand hydrodynamics and support hydrodynamic and sediment transport analysis.
2. Continue Sediment Chemical Stability Analysis
    - Evaluation of Phase 1 data and previously collected sediment chemistry data.
    - Refinement of the geostatistical analysis.
3. Initiate Human and Ecological Risk Assessments
    - Exposure pathway and receptor analysis.
    - Exposure model development.
    - Screening exposure and risk analysis.
    - Identification of potential river/bay risk drivers.
4. Development of Phase 3 Work Plan
    - Analysis and interpretation of Phase 1 and 2 work.

Phase 3 (2008) Activities to Supplement/Improve the Understanding of Sediment Physical Stability

1. Continue Hydrologic Study
    - Water level and flow monitoring.
    - Monitoring during wet-weather and dry-weather periods with both boat mounted equipment and long-term in-river equipment deployments.
2. Sediment Transport Studies
    - River / bay morphology characterization.
    - Measurement of sediment physical characteristics (e.g., PSD, bulk density, TOC, settleability).
    - Sediment stability studies for river and bay sediments, river banks, and floodplain soils.
    - Hydrodynamic modeling.
3. Sediment Stability Assessment
    - Modeling.
    - Measurement of sediment shear strength.
    - Sediment geochronology.

Phase 3 (2008) Activities to Supplement/Improve the Understanding of Sediment Chemical Stability

1. Floodplain Soils Characterization
2. River / Bay Sediment Sampling
    - Additional sediment sampling based on findings from 2007 sampling.
    - Physical characterization.
    - Chemical characterization.

Phase 3 (2008) Activities to Supplement/Improve the Understanding of Human Use and Ecology / Biological Conditions

1. Ecology Studies
2. Ecological and Human Health Risk Assessment
   - Assess human health risks, if any, associated with drinking water.
   - Assess human health risks due to potential direct exposure to sediment in beaches.
   - Assess human health risks due to potential direct and indirect exposures to river sediments.
   - Assess ecological risks due to surface sediment exposures in the river and bay, and contributions of natural recovery processes via burial or natural attenuation of surface sediment contaminants.

2.3 Data Quality Objectives

The DQOs developed to support the Phase 1, 2, and 3 Work Plans will ensure that the proper type and quality of site characterization data will be collected to meet the objectives of the Work. The DQOs will be consistent with those developed for the Tittabawassee River RIWP. The DQOs will be focused on important environment and risk –related questions (such as those identified in Section 1 above) and the following types of data needs:

- Characterization of the physical system
- Potential contaminants of interest
- Nature and extent
- Fate and transport
- Human health risk assessment
- Ecological risk assessment
- Consideration of phased data collection
- Evaluation of a full range of interim and final remedial alternatives

2.4 Hydrology

Work activities will address hydrodynamics using existing studies and additional field studies. Understanding surface water hydrology contributes to understanding sediment transport processes and river morphology, including sediment deposition, sediment stability, and suspended sediment transport. The fate and transport of hydrophobic contaminants strongly sorbed to sediment particles is strongly linked to the fate and transport of the sediment particles themselves. In net depositional environments, this can lead to the accumulation of sediment contaminants, and burial following source control. In areas where higher flow velocities limit the amount of burial and net sediment deposition, contaminated sediment particles may be transported downstream to relatively quiescent areas.

2.5 Geomorphology and Sediment Characteristics

Work activities will characterize the river morphology and sediment characteristics, with particular focus on its influence on contaminant deposition and burial, contaminant transport, and the overall river ecology (e.g., the role of natural levies, bottom river sediment, wetlands, varying shoreline deposits, and other formations relevant to the natural health and ecological status of the river and bay ecosystems).

Understanding the geomorphology of the river system contributes to understanding sediment behavior in the Saginaw River and Bay. In fact, surface water hydrology and river morphology are closely interconnected; understanding one contributes to understanding the other. Erosion and deposition are the primary processes that operate in the river/floodplain system. Erosion may dominate in some areas (particularly along the outer cut banks of meanders), while deposition will dominate elsewhere (particularly along the inner point bars of meanders). The general locations of these processes are predictable and identifiable using hydrodynamics, and by identifying morphologic features.

2.6 Topography and Bathymetry

Work activities will characterize river and bay bathymetry and regional topography using existing information, new field bathymetric surveys, and new topographic surveys. Regional topography and river and bay bathymetry are essential to understanding and modeling surface water flows, and thus contribute to the understanding of hydrologic behavior and river morphology. River bathymetry aids in developing a better understanding of net current velocities, localized velocities, and the capacity of the river during normal and high flow conditions. Topography influences the flow of water into the river from the watershed and contributes to hydrologic and sediment loads into the river and bay ecosystems. Topography also defines flood areas and flow conditions during flood events.

2.7 Floodplain Soils

Floodplain soils will be evaluated using available bathymetric and topographic information, including data from surveys conducted during Phase 1 work, and hydrologic and other relevant environmental modeling results to better understand the extent to which floodplain soils may be impacted by the river. Characterization of floodplain soils will be conducted only as needed if initial chemical surveys, hydrodynamic modeling, analysis of historic floods, bathymetry and topography, and past chemical characterization indicate additional evaluation is warranted.

2.8 Saginaw River Sediments

Characterization of Saginaw River sediments will be evaluated following initial bathymetric and topographic work planned during Phase 1 (2007) and review of available data to better understand areas of potential concern. The approach to sediment sampling will be tiered, in order to optimize sample locations, expedite sampling, and manage costs and schedule. The tiered approach will be founded on a

review of existing sediment chemistry data and geostatistical analyses to understand chemical distributions in the river. The geostatistical analysis will identify areas that do not require further characterization based on existing data and areas that require further confirmation sampling and detailed characterization to support a risk assessment. Initial sediment sampling may be conducted during Phase 1 (2007) to collect data to verify the results of the geostatistical analysis and inform the design of sediment sampling activities in Phase 3 (2008). Following this initial round of sampling and data evaluation in 2007, the second round of sampling in 2008 will target various portions of the river to establish the distribution in sediments of dioxins and other PCOIs associated with historical releases from the Dow Midland Plant. The results of the geostatistical analysis, results from Phase 1 sampling (if conducted), and a proposed sampling plan will be presented in the Phase 3 (2008) Work Plan.

2.9 Saginaw Bay Water and Sediments

Characterization of Saginaw Bay sediments and surface water will be conducted as part of Phase 1 (2007) and Phase 2 (2007/08) work. Work activities in Phase 3 (2008) will be dependent on the results of Phase 1 and 2. Work will include the following activities:

- Collection and chemical testing of water samples collected from drinking water intakes located in Saginaw Bay as part of Phase 1 work conducted in 2007.

- Assessment of human health risks associated with dioxins and other substances in drinking water derived from water intakes located in the bay as part of Phase 2 work conducted in 2007/08. This will involve analysis of historical data and new information collected as part of this Phase 1 or 2 work and assessment of human exposure using the current understanding of dioxin chemistry, historical drinking water records, exposure modeling as appropriate, and risk analysis.

- Collection and chemical testing of sediment samples collected from certain beaches located along Saginaw Bay as part of Phase 1 work conducted in 2007.

- Assessment of human health risks associated with direct and indirect contact with dioxins and other substances in beach sediments as part of Phase 2 work conducted in 2007/08. This will involve the analysis of hydrologic sediment transport conditions to identify the predominant direction of surface water and sediment transport in the bay and shoreline recreational areas. The assessment also will involve analysis of historical data and new information collected as part of Phase 1 or 2 work and assessment of human exposure using the current understanding of dioxin chemistry, recreational activities, exposure modeling as appropriate, and risk analysis.

- Assessment of ecological exposure and risks associated with direct exposure and food chain transfers of dioxins and other substances from surface water and surface sediments in

Saginaw Bay, and contributions of natural recovery processes via burial or natural attenuation of surface sediment contaminants. This work will be conducted as part of Phase 2 work conducted in 2007/08.

2.10 Environmental Chemistry

The Saginaw River / Bay have been the focus of sampling and investigation for more than 30 years. Since 1997, sediment samples from the Saginaw River / Bay have been collected by the U.S. Army Corps of Engineers (USACE), MDEQ, and contractors working on behalf of Dow (e.g., ATS, CH2MHill and ENVIRON); floodplain soil samples have been collected by MDEQ; surface water chemistry samples have been collected by USACE and ENVIRON, on behalf of Dow; and biota samples have been collected by MDEQ and their contractors. With few exceptions, samples of all media have been collected from all four reaches of the river (the USR, LSR-SC, and LSR-BC) and the bay.

Work activities will focus only on contaminants that are found in the Tittabawassee River and associated with historical releases from the Dow Midland Plant. In heavily industrialized areas, such as the Saginaw River / Bay, contaminant stressors are rarely limited to a single contaminant. Understanding the range of contaminants present in sediments – and their sources – may contribute to understanding the range of biological effects that may be present in the river and bay. Based on the results of Phase 1 and 2 work, further characterization may be conducted as part of Phase 3 work in river sediments, adjacent floodplain soils, and bay sediments.

2.11 Human Health and Ecological Risk Assessment

The Phase 2 Work Plan will describe work consistent with current state and federal human health risk assessment (HHRA) and ecological risk assessment (ERA) methods. The work described in the Work Plan will provide the information required to evaluate exposure pathways and potential risks to human health and ecological receptors in and along the Saginaw River / Bay.

The HHRA and ERA will identify and screen receptors of potential concern in a systematic and detailed manner, identifying receptors that exhibit complete TEQ exposure pathways. Potential exposure pathways for both human and ecological receptors will focus on dietary exposures and direct contact with river sediment, wetland soil, and some floodplain soil. Receptors of potential concern are those populations that consume fish or have direct contact with river and wetland sediment or floodplain soil. Because risk assessment is an inherently iterative process, potential chemicals of interest (PCOI), receptors, and exposure pathways will continue to be refined during the Work. The initial list of PCOIs will not be limited to dioxins and may include substances identified from data developed as part of the Tittabawassee River RIWP, as well as substances identified from data describing inputs from other river confluences and point or non-point sources. Further, the ERA will include non chemical stressors such as historically altered hydraulic and sedimentation loads, nutrient loading, shipping and recreational boating, or urban runoff.

2.12 Public Participation Plan

Where relevant and appropriate, elements of the public participation process developed for the Tittabawassee River RIWP will be referenced in Phase 1, 2, and 3 Work Plans and adopted for this Work.

2.13 RIWP Process

Where relevant and appropriate, elements of the Field Sampling Plan, Quality Assurance Project Plans, Health and Safety Plan, and Data Quality Objectives Plan developed for the Tittabawassee River RIWP will be referenced in Phase 1, 2, and 3 Work Plans and adopted for this Work.

3. PROPOSED PHASE 1 WORK ACTIVITIES

Phase 1 investigations proposed to begin in September 2007 will include the following: activities

- Topographic, bathymetric, and geophysical surveys,
- Installation of water level and flow meters (hydrologic monitoring),
- River morphological studies,
- Geospatial analysis of available data to determine the need for focused river / bay sediment sampling,
- Sampling of sediments from certain beaches in Saginaw Bay, and
- Sampling of water from drinking water intakes located in Saginaw Bay.

Prior to implementation of Phase 1 work, project planning activities will be conducted, including refinement of project schedules; preparation of a health and safety plan; coordination, scheduling, and contracting with subcontractors; and procurement of field equipment. The field project team will apply for and obtain permits, where appropriate, from MDEQ and/or the U.S. Army Corps of Engineers (USACE) and provide notification to river and bay property owners, as appropriate.

3.1 Topographic, Bathymetric, and Geophysical Surveys

To assist with sediment investigation activities and the evaluation of sediment remedy alternatives, physical surveys will be performed in the river and bay, beginning at the confluence of the Saginaw and Tittabawassee Rivers, extending to the mouth of the Saginaw River at Saginaw Bay, and including portions of Saginaw Bay. Subaqueous surveys will include bathymetry and potentially three types of geophysical surveys (including side scan sonar, sub-bottom profiling, and magnetometer surveys). Land surveys will include LiDAR-surveys to delineate topography within the floodplain of the Saginaw River. These surveys will provide information necessary to characterize water depths under varying flow conditions, subsurface contours of the river bottom and bay, topography of adjacent land areas, and the presence of obstacles that may influence the collection of sediment samples and cores or the remedy itself (e.g., the presence of debris that may influence remedy selection and remedy implementation).

a. River and Bay Bathymetric Surveys

A bathymetric survey will be conducted to develop an accurate representation of the depth and morphology of the river bottom and southwest portions of the bay. The survey will be conducted using standard industry protocols such that the acquired data are accurate and repeatable, with a calculable error, for offshore horizontal and vertical coordinates. A boat equipped with a survey grade digital recording depth sounder, Differential Global Positioning System (DGPS), and an onboard real-time vessel track line control system will be used to record the bottom profile of the river. The bathymetric survey will use the Michigan State Plane Coordinate System (international feet) (MISPCS) North

American Datum of 1983 (NAD 83) and the National Geodetic Vertical Datum of 1929 (NGVD 29) for horizontal and vertical referencing, respectively. The bathymetric survey will include both coarse grid and fine grid bottom profiling, as needed to define bathymetric conditions at a sufficient level of detail to support hydrodynamic modeling. The Work Plan will identify appropriate grid spacing.

b. River and Bay Geophysical Surveys

Geophysical surveys will be conducted using remote sensing technology to obtain current sub-bottom stratigraphy, magnetic field intensity, and geomorphologic information useful for interpretation of the subsurface geologic conditions for a sediment transport study, for evaluation and design of sediment remedial options, and to identify potential subsurface utilities or obstructions at proposed sediment coring locations. The survey will be conducted using standard industry protocols such that the acquired data are accurate and repeatable, with a calculable error, for offshore horizontal and vertical coordinates. The geophysical surveys will use MISPCS NAD 83 and NGVD 29 for horizontal and vertical referencing, respectively.

Geophysical survey activities will include (a) magnetometery to locate buried debris, pipelines, or other obstructions that may impact investigation or remedial efforts; (b) side scan sonar to evaluate surficial sediment texture and uniformity, and to further identify surficial debris, pipelines, or other obstructions that may impact investigation or remedial efforts; and (c) sub-bottom profiling (chirp) sonar to detect and map the subsurface stratigraphic sequence of sediments in the study area.

c. Topographic Surveys

Topographic surveys of the Saginaw River floodplain will be conducted using LiDAR-surveys to obtain current and sufficiently detailed topographic information for analyzing normal flow and flood conditions, specific areas prone to flood, watershed flow conditions, and modeling. The survey will be conducted using standard industry protocols such that the acquired data are accurate and repeatable, with a calculable error for offshore horizontal and vertical coordinates.

3.2 Hydrologic Monitoring

Hydrologic studies will be initiated during Phase 1 work to support the development of a 2-dimensional hydrodynamic model during Phases 2 and 3 work that describes flow conditions in the Saginaw River / Bay, and to support remedy evaluation and selection. In Phase 1, work will include the installation and monitoring of surface water elevation gauges and measurement of surface water flow velocities to establish hydrodynamic boundary conditions along the river and in Saginaw Bay under varying flow conditions and provide data to construct and calibrate the hydrodynamic model.

Monitoring will include water level and flow velocity measurements at locations near the mouth, at the river midpoint, and near the confluence of the Shiawassee and Tittabawassee Rivers. Flow

velocities will be measured using Acoustic Doppler Current Profiling (ADCP) methods. Water level will be monitored with bridge-mounted radar downlookers. These data will be used to supplement existing USGS datasets. Deployment through the winter is not planned due to freezing and potential instrument damage, except possible measurements uniquely designed to evaluate winter-specific conditions. These data will be used to augment the existing record of data available at the river mouth (USGS gauge 04157065) and near the Shiawassee River and Tittabawassee River confluence (near Rust Avenue Bridge, USSG gauge # 04157000).

3.3 Morphologic Characterization

Morphologic characterization will include bottom sediment and river bank assessments, and will include a measurement of river sinuosity, and identification and characterization of sediment deposits, levees, scour areas, plants, and their structures. Studies will include analytical interpretations of the geophysical and topographic data, and will include video and river bank classification surveys for additional field characterization. The video and bank classification results will be compared to the geophysical results and hydrodynamic studies to obtain a comprehensive picture of river and bay morphologies.

The Video / GIS survey of both river banks along the Saginaw River will be conducted by gathering a tight video shot of each bank of the river as a continuous survey. The video stream will be linked to a continuous record of GPS location, allowing the data to be accessed by spatial location. A final deliverable following the survey will be an interactive map showing the survey tracks and windows for the parallel bank videos. A click and drag “camera” icon can be used to browse the video by location along the survey line. The video survey can be used as a medium to review current conditions and address concerns regarding bank stability and TEQ source areas.

The river-bank classification survey will follow the approach used on the Kalamazoo River as part of sediment investigations conducted by other parties in 2005 and involving MDEQ and U.S. EPA Region 5. The survey provides a means for classifying river bank conditions based on slope, degree of undercutting, vegetation and other surface cover, physical nature of the bank material, and related physical factors and geomorphologic characteristics that contribute to bank stability. The results of the survey will be used to prepare a complete GIS-based inventory of bank characterization, stored as a linear GIS coverage of all data attributes for each bank of the river.

3.4 Saginaw Bay Water and Beach Sediment Chemical Characterization

Sampling will be conducted to determine the presence of dioxins and other PCOIs in surface sediments from certain beaches along Saginaw Bay. Beach sediment sample locations will be identified in the Work Plan. Sampling will focus on the following beaches included in 2006 studies conducted by MDEQ (MDEQ 2006):

- Bay City State Park (BCSP, also referred to as the Bay City State Recreation Area). This is the furthest beach located west of the mouth of the Saginaw River.
- Vanderbilt Park, located east of the mouth of the Saginaw River.
- Fish Point Wildlife Area (FPWA) located furthest east of the mouth of the Saginaw River.
- Finn Road Public Boat Launch located east of the mouth of the Saginaw River.
- Aplin Beach (also referred to as Wenona Beach), located west and between the mouths of the Kawkawlin River and Saginaw River.
- Saginaw Bay West Boat Launch, located between Aplin Beach and Bay City State Park to the west of the mouth of the Kawkawlin River.

Review of existing data will be conducted to determine if the available dataset indicates spatial patterns or trends in TEQ concentrations in beach sediments, and to provide guidance for performing Phase 1 sampling. The initial data review and subsequent sampling design will be guided by spatial statistics, in tandem with other knowledge of the bay, including hydrodynamics, sediment transport, shoreline morphology, historical dredging and other human use activities.

In addition, water samples will be collected at pumping stations located onshore that handle the flow of bay water drawn from drinking water intakes located in Saginaw Bay. Filtered and unfiltered water samples will be tested for dioxins and other PCOIs. The results will be used to support risk assessment activities conducted as part of Phase 2 work, and to evaluate the need for additional sampling and testing as part of Phase 3 work.

3.5 Saginaw River Sediment and Soil Chemical Characterization

Depending on the results of a preliminary analysis of river hydrodynamics, geomorphological conditions, and geostatistical treatment of the available historical sediment data, focused sediment sampling may be conducted in the Saginaw River as part of Phase 1 work to improve the understanding of historical sampling results and define Phase 3 (2008) sediment sampling. If conducted in Phase 1, the approach to sediment sampling will likely be limited and focus only on addressing data gaps or to verify the results from historical sampling. The approach to understanding the available sediment data and determining the need for sampling in Phase 1 will be based on the following activities:

- Compilation and review of existing sediment chemistry data for TEQs and for other PCOIs,
- Geostatistical analysis to identify the spatial and depth profile of TEQ distributions in the historical river sediment and floodplain soil dataset,
- Identification of areas in the river that do not require further characterization based on the existing data, and areas that require further confirmation sampling and/or detailed characterization to support risk assessment,
- Development of a sampling plan, if appropriate, involving the collection of samples at specified locations to verify the geostatistical results and/or address data gaps, and
- Implementation of sampling work as part of Phase 1 work.

Review of existing data will be conducted to determine if the current dataset indicates the presence of spatial patterns or trends in TEQ concentrations in Saginaw River sediments and floodplain soils, and to provide guidance for future sampling based on the analysis results. Spatial statistical methods have been well developed for application to environmental data (Goovaerts 1997) and have been applied in numerous studies of sediment and soil contamination (e.g. Barabás et al. 2001). The initial data review and subsequent sampling design will be guided by spatial statistics, in tandem with other knowledge of the system including hydrodynamics, sediment transport, river morphology, historical dredging activities, and historical sourcing.

It is expected that the spatial distribution of TEQs will vary differentially across and along the flow direction, with the depositional environment, and inside and outside of the dredged channel. In addition, if potential primary or secondary TEQ sources are located along the Saginaw River, such sources may influence concentration distributions. Further contaminant sampling in the river sediments will be planned based on the findings of the initial geostatistical evaluation, and further delineation of the different environments described above. The initial sampling and data evaluation conducted as part of Phase 1 (2007) work will be used to inform the development of Phase 3 (2008) sampling work.

3.6 Sediment Physical Characterization

If sediment and floodplain soil sampling occurs during Phase 1 work, sediments will be characterized for particle size distribution, suspended solids, bulk density, porosity, total organic carbon, redox conditions, and pH to better understand varying morphologies, habitat types, geochemistry, and hydrodynamic influences on sedimentation behaviors.

4. SCHEDULE AND DELIVERABLES

The schedule and important milestones for implementation of the work described in this SOW is presented in Table 4-1.

Table 4-1. Schedule of Saginaw River / Bay Work Program

Task	Anticipated Start Date		Anticipated Completion Date
License Condition XI.B.6 Triggering the Preparation of SOW	June 12, 2007		--
Submission of SOW to MDEQ	July 13, 2007		--
The SOW describes the overall approach for conducting work in the Saginaw River / Bay. The Work is described in 3 phases of investigation, with river/bay field work conducted in fall 2007 and spring/summer/fall 2008.			
Phase 1 Activities			
Preparation of Phase 1 Work Plan	July 13, 2007		September 1, 2007
Submission of Phase 1 Work Plan	September 1, 2007		--
Phase 1 (2007) Work Activities	September 1, 2007		November 15, 2007
Data Reporting	60 days after the end of each calendar quarter		
Preparation of Phase 1 Summary Report	November 15, 2007		January 31, 2008
Submission of Phase 1 Summary Report	February 1, 2008		--
The Phase 1 Work Plan describes investigation and river/bay field work activities to be conducted during the fall 2007. Data gathering activities will begin in September to maximize time available for field work before the onset of winter requires cessation of work on the river/bay. The Phase 1 Summary Report will summarize work performed during Phase 1, and include data, interpretation of findings, and other relevant supporting information.			
Phase 2 Activities			
Preparation of Phase 2 Work Plan	October 15, 2007		December 1, 2007
Submission of Phase 2 Work Plan	December 1, 2007		--
Phase 2 (2007/08) Work Activities	December 2, 2007		March 1, 2008
Data Reporting	60 days after the end of each calendar quarter		
Preparation of Phase 2 Summary Report	March 1, 2008		May 31, 2008
Submission of Phase 2 Summary Report	May 31, 2008		--
Preparation of the Phase 2 Work Plan will begin concurrent with the implementation of Phase 1 work. Phase 2 work includes initiation of hydrologic and hydrodynamic modeling, development of human and ecological risk assessments, and review/interpretation of Phase 1 data and data compiled in a *Current Conditions Report*. The results of Phase 2 work will inform the scope of activities warranted as part of Phase 3 work. Modeling and risk assessment activities will begin in December to maximize time available for data analysis, model development/refinement, and decision-making for 2008 field work. The Phase 2 Summary Report will summarize work performed during Phase 2, and include data, interpretation of findings, and other relevant supporting information.			

Phase 3 Activities			
Preparation of Phase 3 Work Plan	February 1, 2008		May 1, 2008
Submission of Phase 3 Work Plan	May 1, 2008		--
Phase 3 (2008) Work Activities	May 2, 2008		November 15, 2008
Data Reporting	60 days after the end of each calendar quarter		
Preparation of Phase 3 Summary Report	November 15, 2008		February 1, 2009
Submission of Phase 3 Summary Report	February 1, 2009		--

Preparation of the Phase 3 Work Plan will begin concurrent with the implementation of Phase 2 work. The Phase 3 Work Plan describes investigation and river/bay field work activities to be conducted during the spring/summer/fall 2008. Work will begin in May to maximize time available for conducting sediment and biological sampling and monitoring tasks that should consider the potential for changed conditions due to seasonal (spring, summer, and fall) variations. The Phase 3 Summary Report will summarize work performed during Phase 3, and include data, interpretation of findings, and other relevant supporting information.

Overall Report of Findings			
Preparation of Report	February 1, 2009		May 1, 2009
Submission of Report of Findings	May 1, 2009		--

Preparation of the overall Report synthesizes the investigation summary reports and data developed during Phases 1, 2, and 3 and represents the comprehensive report of the river and bay and satisfies License Condition XI.B.6. Further, the Report results will inform the need, if any, for interim measures and the preparation of remedy assessments and corrective actions for the river and/or bay.

5. REFERENCES

Barabás N, Goovaerts P, Adriaens P. 2001. Geostatistical Assessment and Validation of Uncertainty for Three-Dimensional Dioxin Data from Sediments in an Estuarine River. Environ Sci Technol. 35(16):3294-301. August 15.

Goovaerts, P. 1997. Geostatistics for Natural Resources Evaluation. Oxford University Press.

Michigan Department of Environmental Quality (MDEQ). 2006. *Table 5. Saginaw Bay Floodplain Total TEQ in ppt*. Final Report of Dioxin-Like Toxicity in the Saginaw Bay Watershed. Great Lakes National Program Office. Grant Project # GL965334010; and PBDE Distribution in the Saginaw Bay Watershed. Great Lakes National Program Office. Grant Project # GL96558601-0. Prepared by A.B. Taylor, D.R. MacKenzie-Taylor, A. Ostaszewski, J. M. McCabe. May 2, 2007. Revised August 31, 2006. Page 14 of 38.

*** END ***

TABLES

TABLE 1-1. Addressing the Requirements in The Dow Chemical Company's State of Michigan Hazardous Waste Operating License

Requirements in Dow's License	MDEQ Expectations for the Saginaw River and Bay RIFS *	Comments / Where Addressed in SOW
XI.B.3. - Submit for approval by the Chief of the Waste and Hazardous Materials Division	• May be able to use Technical Teams for advisory purposes or as part of the "working meeting" process	• Propose to use ADRM technical working group for review.
XI.B.3.(a) - Identification of specific interim response activities (IRAs)	• Considerations could include expansion of current sediment trap pilot program	• Propose to use ADRM technical working group for review.
XI.B.3.(b) - Phasing and prioritization of work and schedule	• Enforceable schedule is needed – critical component • Requirements of Part 201 R 299.5528(3) must be addressed [Remedial Investigation (RI) requirements] – see attachment • Also include sampling of public beaches and water plant intakes as identified in Framework document • Schedules for SOW work must be incorporated into the detailed Compliance Schedule under Condition XII.A. of the license	• The schedule of work is described in Section 4 of the SOW. • Requirements of Part 201 are addressed in the SOW. • Sampling public beaches and water plant intakes will be conducted as part of Phase 1 work, as described in Section 3 of the SOW. • Proposed schedule in Section 4 of the SOW can be incorporated into the detailed Compliance Schedule.
XI.B.3.(b)(i) – Identification of additional exposure pathways	• Need to identify exposure pathways (including but not limited to high end fish and wild game consumers)	• Exposure pathways will be identified as part of Phase 2 work addressing human health and ecological risk assessment, as described in Section 2 of the SOW.

Requirements in Dow's License	MDEQ Expectations for the Saginaw River and Bay RIFS *	Comments / Where Addressed in SOW
XI.B.3.(b)(ii) – Process for selecting areas of investigation	• Use of sub-bottom profiling and bathymetry to assist in selection of sampling locations similar to proposal in MTR SAP • Current conditions report to identify data gaps • Public beaches and water intakes as identified in Framework document • Requirements of R 299.5528(3) need to be considered/addressed	• Bathymetry and geophysical surveys, including sub-bottom profiling, are proposed in Phase 1 work, as described in Sections 2 and 3 of the SOW. • A *Current Conditions Report* will be prepared in Phase 1 work, as described in Sections 1 and 2 of the SOW. • Sampling public beaches and water plant intakes will be conducted as part of Phase 1 work, as described in Section 3 of the SOW. • Requirements of R 299.5528(3) are addressed in the SOW.
XI.B.3.(b)(iii) – Proposed steps to determine if there are continuing sources of contamination	• Evaluation of Tittabawassee River as continuing source as well as Saginaw River and Bay reservoir sources	• The work will evaluate the likelihood of the Tittabawassee River as a continuing sources of contamination to the Saginaw River and Bay, as described in Section 2 of the SOW.
XI.B.3.(b)(iv) – Proposed steps to develop site-specific cleanup criteria	• Need to be considered	• Will be addressed as part of the Tittabawassee River RIWP process.
XI.B.3.(b)(v) – Ecological risk assessment	• Need to propose and include in schedule	• Ecological risk assessment activities will be included in Phase 2 work, as described in Section 2 of the SOW.
XI.B.3.(c) – Proposed plan for public participation	• Need to propose – may include ongoing quarterly meetings as part of public participation	• Elements will be adopted, where appropriate, from the Tittabawassee River RIWP process.
XI.B.3.(b) - Enforceable Schedule	• Critical component – needs to be proposed	• The schedule of work is described in Section 4 of the SOW.

Requirements in Dow's License	MDEQ Expectations for the Saginaw River and Bay RIFS *	Comments / Where Addressed in SOW
Alternate administrative option (i.e., similar to what is contemplated in XI.B.6. and 7.)	• May consider including in the schedule the development of an alternate administrative option to comprehensively address corrective action obligations	• Not addressed in the SOW, Dow will propose separately alternative options to consider.
XI.B.5. – Requirement to submit RI Work Plan	• Need to propose schedule	• The schedule of work is described in Section 4 of the SOW.

Note:

* The statements in Table 1-1 pertaining to requirements in Dow's License (column 1) and Michigan Department of Environmental Quality (MDEQ) expectations for the Saginaw River and Bay RIFS (column 2) were communicated to Dow by MDEQ on July 3, 2007.